An Investigation of Top Quark Pair Production Mechanisms

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Outline

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- The Method
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- Sensitivity to Number of Gluons
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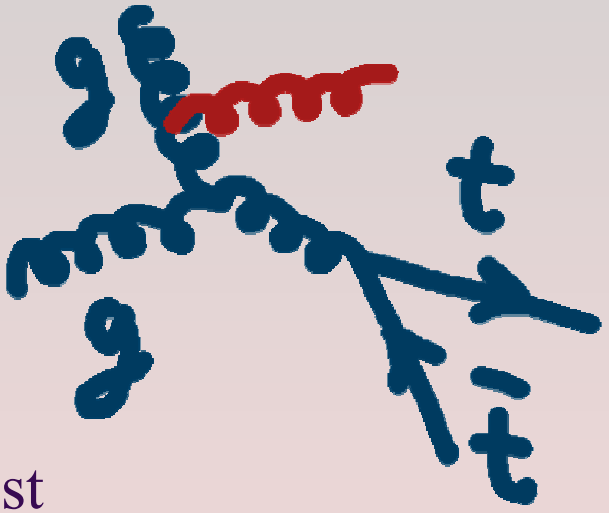
- Summary/Outlook

Introduction

- According to SM, in $p\bar{p}$ collisions at $\sqrt{s} \sim 2$ TeV
  - $gg \rightarrow t\bar{t}$ ~ %15
  - $q\bar{q} \rightarrow t\bar{t}$ ~ %85
- Measure $\sigma_{(gg \rightarrow t\bar{t})} / \sigma_{(q\bar{q} \rightarrow t\bar{t})}$
  - Test of SM
  - Compare to $b\bar{b}$ production
  - Non-SM mechanisms may exist

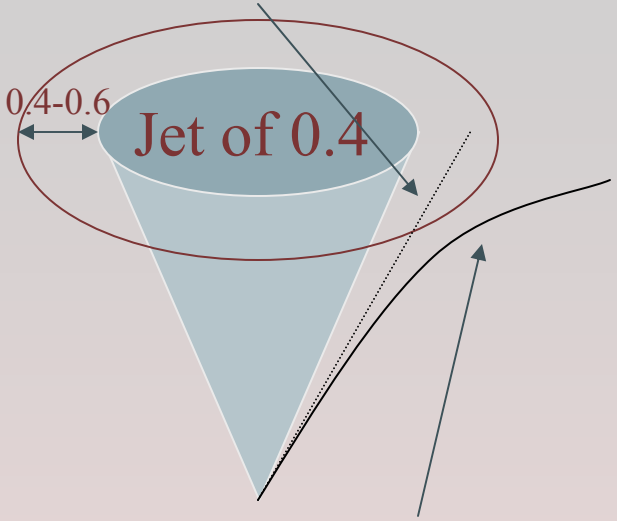


- Processes differ in underlying activity
  - The difference comes from ISR

The Difference

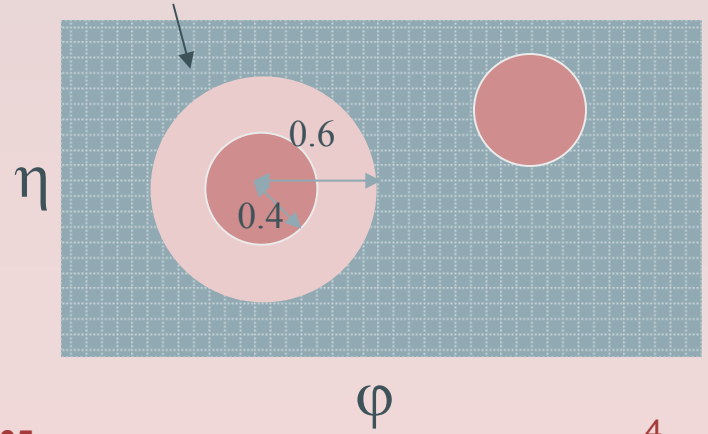
- Larger number of gluons
  - More particles
  - More jets close to beamline
- Track Multiplicity
  - Low p_T (0.3-3 GeV)
  - $|\eta| \leq 1.1$
  - Matched to the event vertex
  - Separated from jets
  - Correct for area differences
- Forward Jet Multiplicity
  - $1.1 \leq |\eta| \leq 3.0$
  - $E_T \geq 9$ GeV

Track if no magnetic field exists

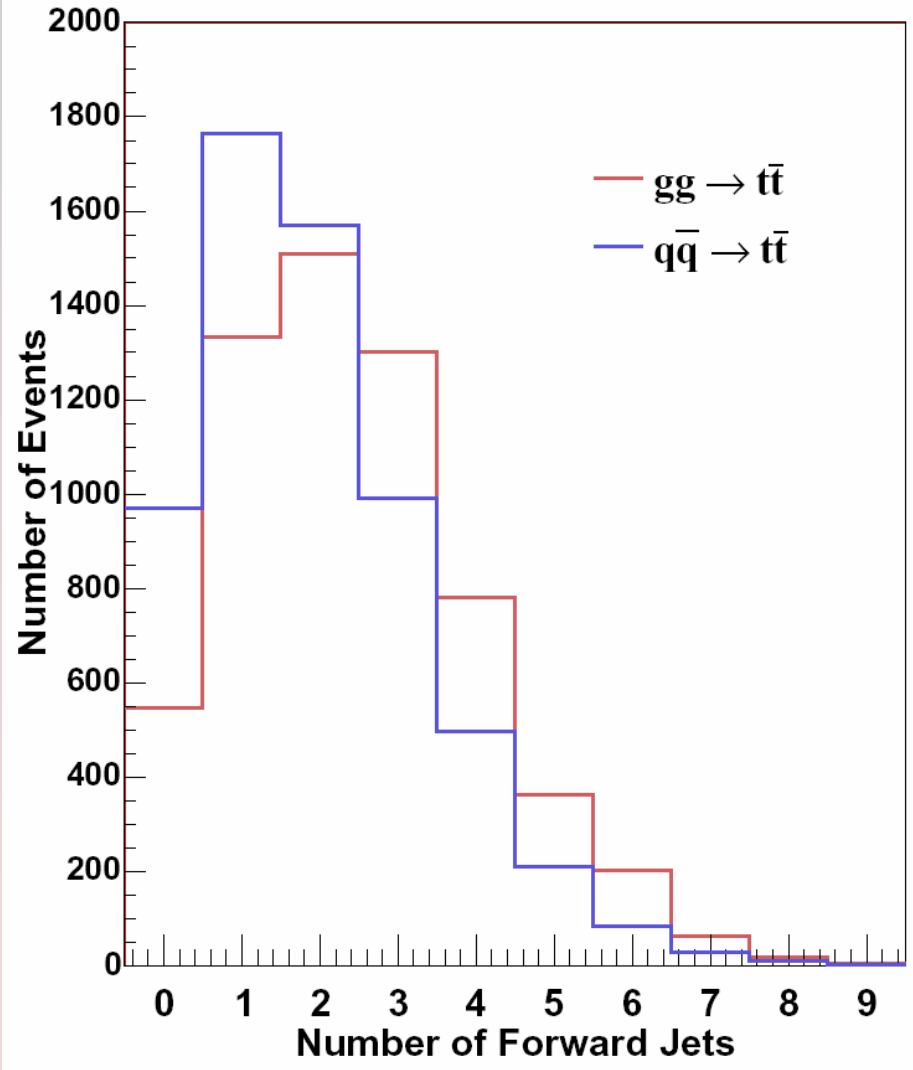


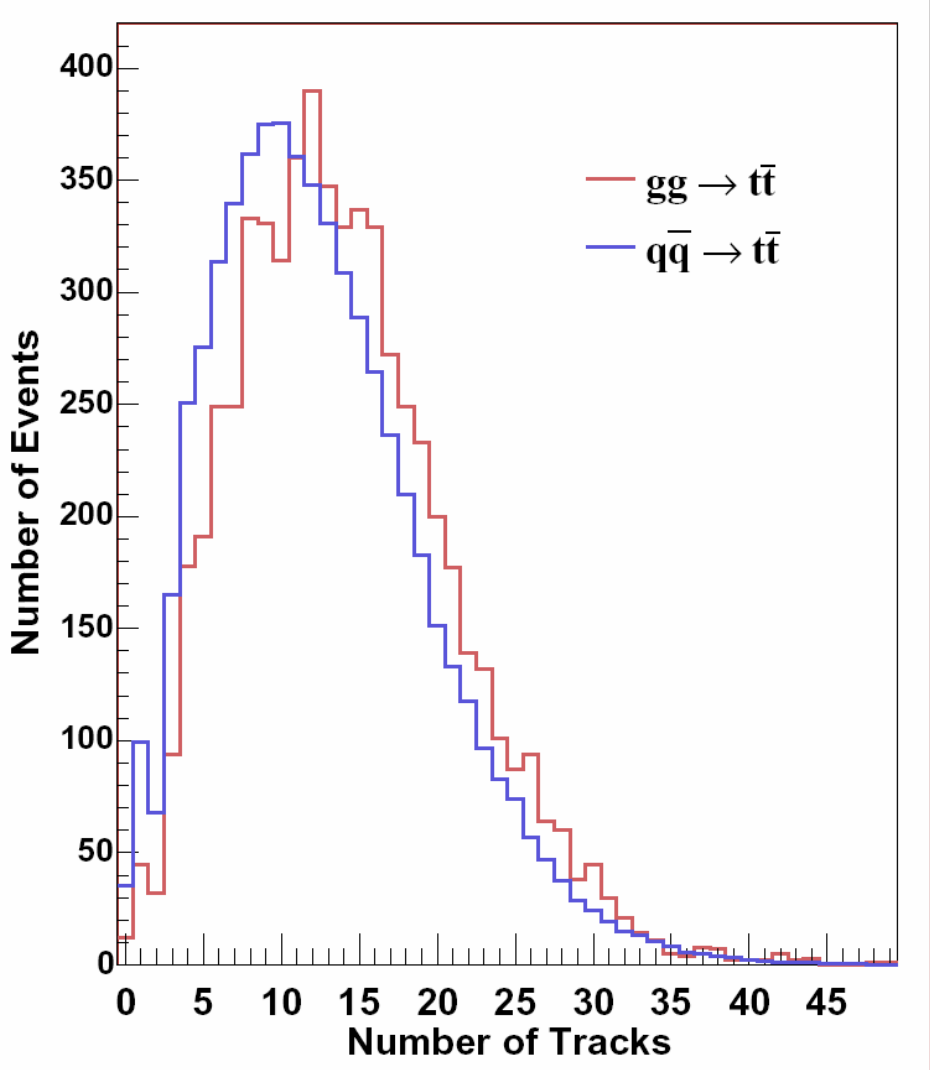
Track in magnetic field

Jet of 0.4 and its annuli



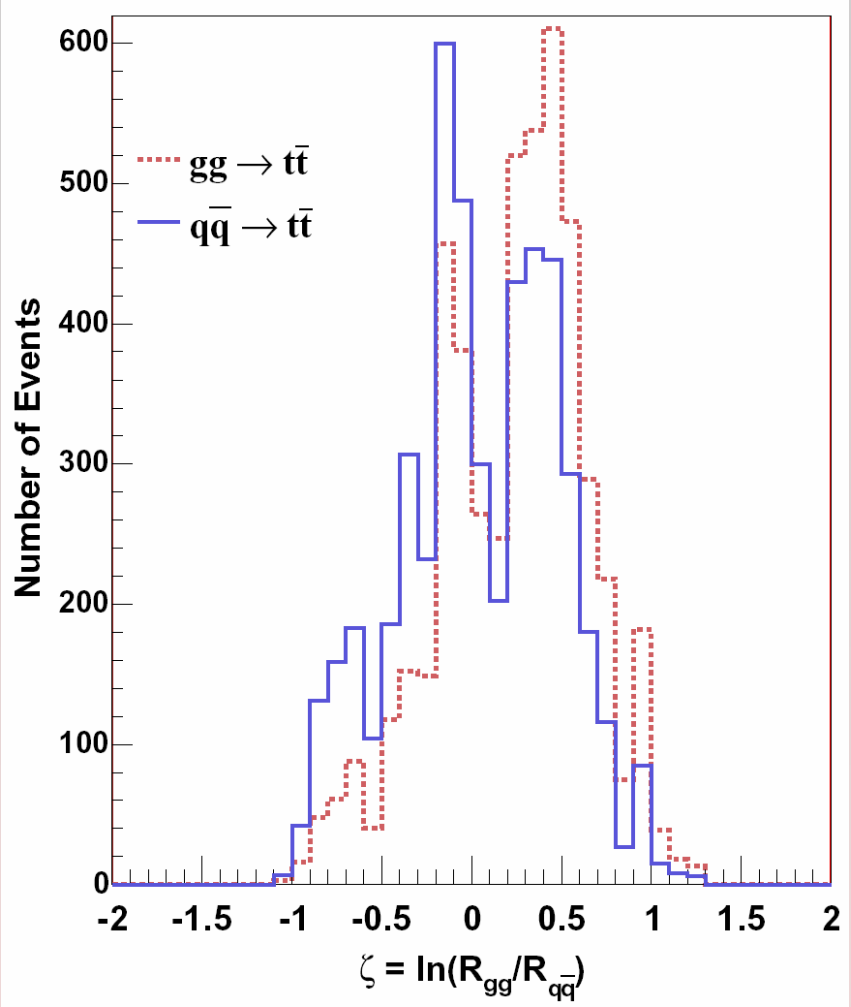
ttbar Comparisons





The Method

- Map 2D distribution of forward jet multiplicity vs. number of charged particles
- Assign probabilities
  - $R_{q\bar{q}}$
  - R_{gg}
- Get distribution of $\zeta = \ln(R_{gg} / R_{q\bar{q}})$
- Parameterize the distributions
- Fit the unknown sample $F(\zeta) = N_{t\bar{t}}[r_{gg} F_{gg}(\zeta) + (1 - r_{gg}) F_{q\bar{q}}(\zeta)]$



Calibration is the Key

- Can not rely on the modeling of gluon radiation
- Solution is to calibrate using data
  - W + n jet events
    - W with no jet is mainly $q\bar{q}'$
    - As jet multiplicity increases, the gluon-content increases
  - Dijet events
    - Gluon-content decreases as the leading jet E_T increases

Details of calibration samples:

Jet in W + 0, 1 or 2 jet categories:

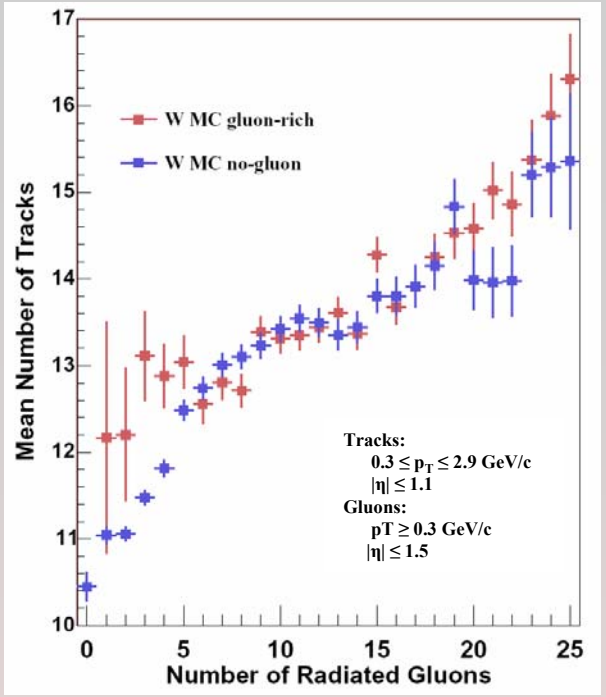
- $E_T \geq 20$
- $|\eta| \leq 2$

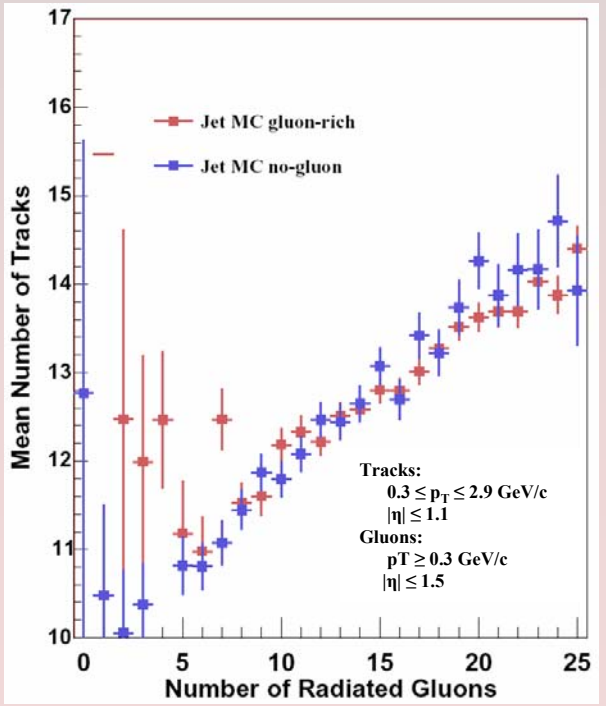
Leading jet in dijet categories:

- starting from 100 GeV
- bins of 20 GeV
- up to 200 GeV

Sensitive to Gluons

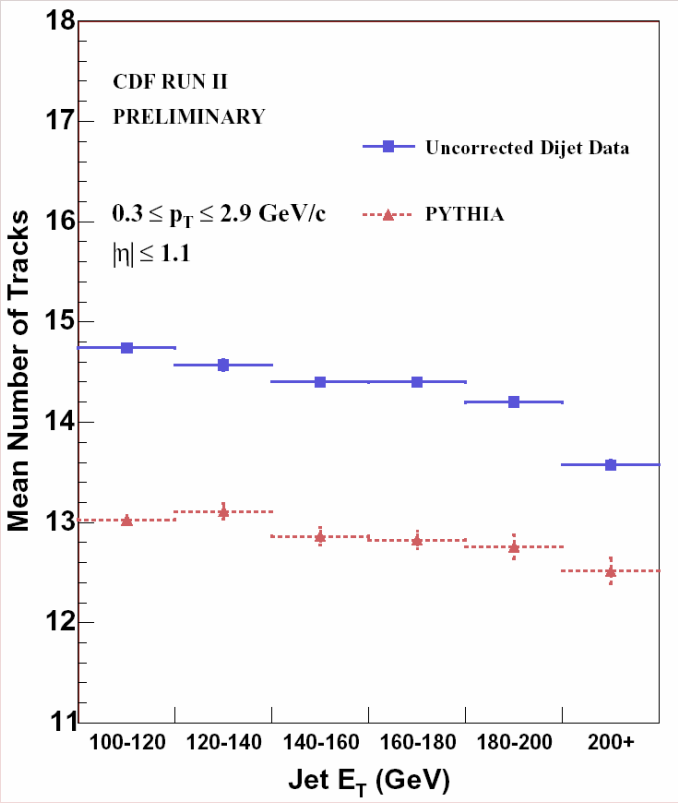
- MC studies show that track multiplicity is sensitive to number of gluons
  - Both initial and final state
  - Calibration samples allow us to explore this
- Little statistics in low gluon radiation for gg/qg sample
- Track multiplicity depends on the gluon radiation rather than n jet category

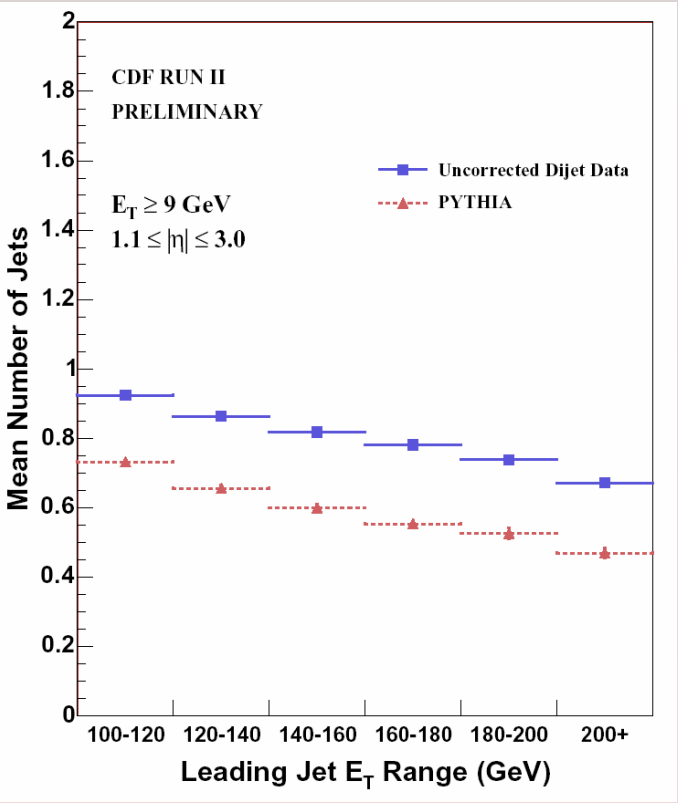




Dijet comparisons

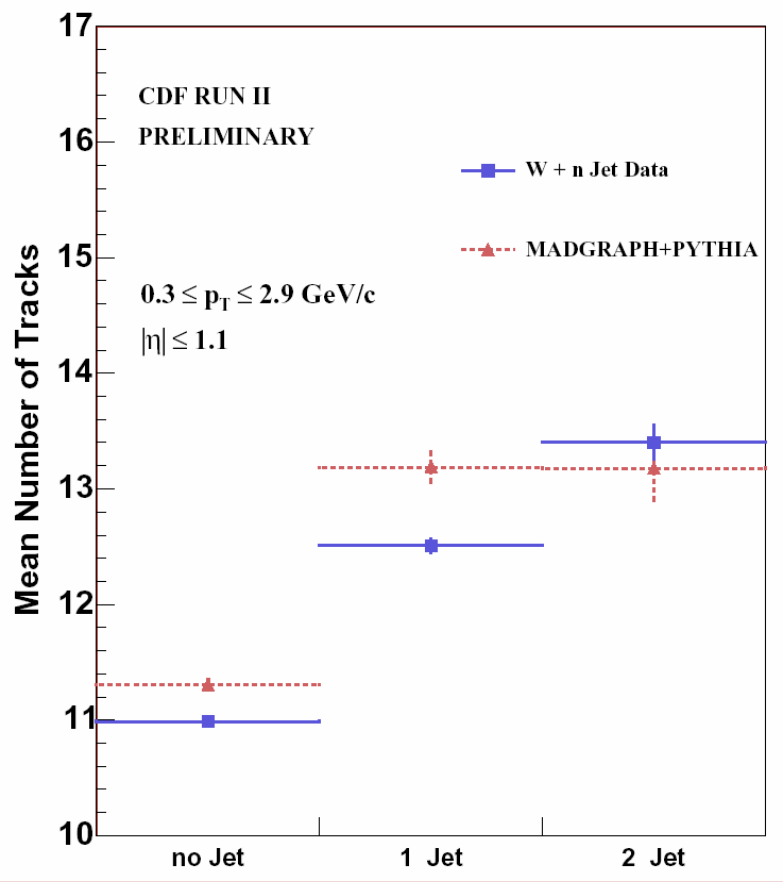
- Data and MC show same trends as gluon-content changes
- MC lacks Multiple Interaction (MI)
- MC is a 2→2 jet production

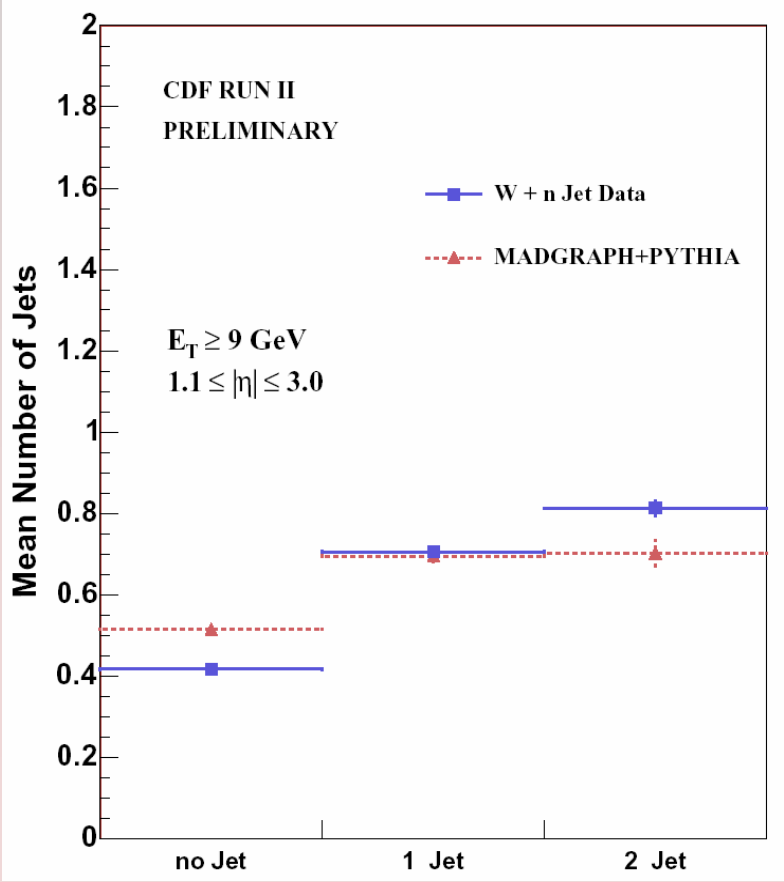




W + n Jet Comparisons

- Data shows the increase expected in multiplicities
- MC shows the increase in W + 0 or W + 1 jet
  - W + 2 jet has large uncertainty





Summary

- Have developed a method to separate gg and qq collisions
- Working on the optimization of technique
- Early studies show consistency of the calibration samples, MC and data
  - Number of modeling issues remain

Next Steps

- Complete calibration studies
- Estimate the precision of technique
- Apply to the largest possible ttbar sample